Pancoast Seminars

Financial Product Education,
Analytics, & Consulting
Capital Markets, Derivative Products, &
Asset Management

Bond Futures

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Bond Futures

Government Bond Markets Overview

German Bund Cash Market

The German government bond market is the fourth largest government bond market in the world, trailing only those of the United States, Japan, and Italy.

Its structure has evolved over the past dozen years to adapt to both the increasing financial demands associated with the reunification effort and the need to offer an attractive market place to the increasingly global investor.

Issuers

The German debt markets feature a wide array of issuers. In fact, the Federal Government sector is not the largest market segment: bonds issued by commercial banks exceed government borrowing.

Other than the normal government debt issued, current outstanding debt also consists of a number of instruments issued by a variety of funds. Among these funds, the most important in terms of current outstanding debt are the Treuhandanstalt and the German Unity Fund ("Fonds Deutsche Einheit").

Both funds were dissolved at the end of 1994: liabilities and outstanding issues remain fully backed by the German Federal Government. The bonds issued by these funds have technical characteristics identical to those of Bunds.

It is the "Bund" issues of the Federal Government together with those bonds issued prior to December 31, 1994 under the name of Unity Fund and Treuhandanstalt which are eligible for delivery into the LIFFE Bund futures contract.

Key Instruments

Bundesanleihen (Bunds) are straight fixed income securities, paying an annual coupon, issued by the Federal Government. The majority of these bonds are issued with an initial maturity of ten years but can range up to thirty years. A ten year Bund issue is accepted as the ten year benchmark for the Deutschmark bond market.

Bundesobligationen (Bobls) are fixed income securities issued by the Federal Government with an initial maturity of five years. Like Bunds, Bobls pay coupon interest annually.

Unverzinliche Schätzanweisungen (U-Schätze) are zero coupon securities essentially equivalent to treasury bills, however their original maturities can range out to two years.

Unterjährige Unverzinsliche Schatzanweisungen (Bubills) are discount securities with a maturity of six months that will be issued on a regular basis in the future.

Bundesschatzanweisungen (Federal Treasury Notes or Schätze) are securities with a maturity of two years, paying an annual coupon.

The Primary Market

The Federal Bond *Konsortium* traditionally issue Federal Government bonds under the lead management of the German Bundesbank.

Auction Calendar

Since the second quarter of 1994, the Bundesbank has issued a quarterly funding calendar indicating planned issues for Federal Government bonds. The calendar gives an indication to the market of the approximate date, size, and maturity of the stock to be issued. Bobls, Schätze and Bubills are generally issued on a quarterly basis beginning in February, March and April respectively. Bund issuance is more irregular.

Bundesanleihen (Bunds)

The process of issuing new Federal Government Bunds generally involves three separate stages. The initial stage of a long term bond issue is handled by a select group of banks (German and foreign-owned) called the Federal Bond *Konsortium*. Around 20% to 30% of the total amount of a new issue, called the first tranche, is allocated to the members of the *Konsortium*.

Immediately after the issue amount underwritten has been agreed, the *Konsortium* are invited by the Bundesbank to place (competitive or non-competitive) bids for the following day, when the second tranche is distributed. All competitive bids above the accepted minimum price are allotted at the actual price bid (U.S.-style auction).

Secondary Market Practices

The secondary market for Bunds is unusual in that a sizeable amount of trading occurs in London as well as Frankfurt. The dominance of the London-based OTC market for Bunds is partially due to the existence of an active and efficient repurchase (repo) market.

In contrast, Frankfurt participants have been subject to minimum reserve requirements on the amount of funds raised via overnight and term repos. Because the reserve requirement is not assessed for funds accessed in London, the Frankfurt repo market has developed slowly. As of the first business day in 1997, overnight and term repos transacted in Frankfurt are no longer subject to minimum reserve requirements.

Secondary market Bund transactions within Germany occur either on one of the eight regional stock exchanges or OTC.

Clearing and Settlement

Deutsche Kassenverein (DKV)

Within Germany, settlement is arranged on a delivery versus payment basis through the Kassenverein depository system.

The standard time to clear is two business days following the trade date.

Euroclear & CEDEL
OTC trading outside of Germany is commonly settled through one of the two pan-European clearing organizations. International settlement is usually three business days following the trade date.

U.S. Treasury Cash Market
The debt instruments issued by the government of the United States constitute the largest debt market in the world. Its development over the years has spawned innovations in practices and conventions that have been imitated throughout the world.

Treasury Instruments

The Treasury of the United States finances the operation of the U.S. government by issuing a variety of securities. A small part of the public financing is delivered in the form of non-negotiable U.S. savings bonds. However, most of the Treasury's financing activities employ the capital market instruments described below.

Treasury Bills are issued in maturities of less than one year. These bills are issued as discount securities with no coupon. While most bills are issued in regularly scheduled auctions of three, six, and twelve month maturity, occasionally the Treasury will auction "Cash Management" bills with unusual maturity dates.

Treasury Notes are coupon securities with initial maturities between one and ten years. Currently, the regular supply of notes are issued in original maturities of two, three, five, and ten years. Notes pay coupon interest semi-annually.

Treasury Bonds are debt instruments issued with an initial maturity greater than 10 years. Bonds are currently issued with an original maturity of 30 years, and pay coupon interest semi-annually. Since 1984 all Treasury bonds have been issued with "bullet" maturities. Prior to 1984 there were regular issues of 20-year maturity bonds and callable bonds. The callable bonds were generally issued with an initial maturity of 30 years, callable at par in 25 years. All new treasury notes and bonds are issued in "book entry" form. Prior to 1986, investors could purchase bearer bonds and many of these bonds are still in circulation.

The Primary Market

The issuance and distribution of new Treasury securities take place in an orderly, well-defined auction process.

Auction Calendar

The Treasury of the United States conducts debt auctions on a regular basis. Each week it auctions both three and six month maturity bills. There is also a one year bill auction once a month.

Treasury notes and bonds are issued somewhat less frequently. Generally, there are auctions of both two year and five year notes each month. Three year and ten year notes are auctioned during what is referred to as the "quarterly refunding" during February, May, August, and November. In addition to these months, the U.S. Treasury will also auction ten year notes during the months of July and October, for a total of six auctions per year.

Treasury bonds are now auctioned during the February, August, and November quarterly refundings. However, prior to 1995 there were regular auctions of 30year bonds during all four of the quarterly refundings and it is possible that the Treasury may return to that schedule.

Auction Timeline

Announcement
During the week prior to the auction, the Treasury makes an announcement of the maturities and exact amounts of all issues to be auctioned.

Auction
At 12:00 p.m. on the auction date, buyers wishing to bid non-competitively must have their bids registered with the Federal Reserve bank in New York. Competitive bids are due at 1:00 p.m.

Auction Process

The actual distribution of issues in the auction is set up through a competitive auction. However, investors may purchase bonds and notes at the average price determined in the competitive auction by offering a "non-competitive" tender.

Large banks and bond dealers submit their competitive tenders to the New York Federal Reserve. The Treasury then organizes all of the tenders, beginning with those offering to buy at the lowest yield. It proceeds through the bids until it reaches a yield level which would fully subscribe the issue.

Bidders at this level are allocated a percentage of their tender.

"When Issued" Trading

Once the announcement of the auction is made, the market begins to trade the new security on a "when issued" basis. During the interval between the announcement and the auction, trades are made by quoting yield. After the auction results are announced, when issued trading continues although the quotations switch from yield to price.

Secondary Market Practices

The secondary market for U.S. Treasury securities is an active and competitive arena with a wide range of participants and strategies. Nearly all secondary market trading is conducted over-the-counter. Treasury bonds and notes are also listed at the New York Stock Exchange. However, this is a formality to satisfy investors who, for regulatory reasons, may be restricted to the purchase of "listed" securities.

Participation Market participants can be broadly grouped into four categories: dealers, brokers, investors, and arbitrageurs.

The most important market makers are the "primary dealers," of which there were 37 as at September 24, 1996. The Federal Reserve conducts its trading activities with these dealers, who must meet the requirements of the Federal Reserve Bank of New York as to integrity, activity and capital reserves.

Bond Futures Contracts

Overview of Contracts

Features which all government bond futures contracts have in common include:

- Contracts for the longest maturities of actively issued government bonds
- Specific deliverable bonds
- Tick values equal to the smallest price change of the underlying bonds

Traders at a Futures Exchange

Whether hedging or speculating, an order is executed publicly and by open outcry by floor traders who are classified as either floor brokers or locals.

Floor Brokers

Floor brokers execute orders to buy and sell for commission houses and institutions such as banks or thrifts. The floor broker's primary function is to execute orders for clients of his or her firm, in return for a fee or commission.

Locals

The *local*, on the other hand, trades strictly for his or her own account. Usually locals engage in one or more of the following types of trading: day trading, scalping, position trading, or spreading.

- The *day trader* initiates and offsets a position in a futures contract during the course of a single trading session. Rarely, if ever, does the day trader go home with an open opposition (that is, one initiated during the course of a trading day but not closed by the end of the session).
- The *scalper* trades a large number of contracts with minimum price fluctuations, perhaps one or two ticks. A position opened one minute can be closed moments later.

- The *position trader* initiates a position and maintains it over an extended period of time-days, weeks, or months. The position trader is not as concerned with minute-to-minute or even hour-to-hour price changes as with the broad market trend.
- The *spreader* is concerned with the shifting relationships between different delivery months for the same contract or between different commodities over time. In initiating this type of transaction, the spreader simultaneously buys (sells) one contract and sells (buys) another.

  Spreaders may take into account shifting relationships between different delivery months, prices, or contracts. When relationships show a deviation from their historical norm, the spreader conducts simultaneous transactions in an effort to profit before prices return to more normal patterns.

  Spreading is used not only by speculators, but by hedgers as well. The risk in spreads is generally less than in an outright purchase (long position) or sale (short position), but the potential for profit also is reduced. Also, spread margin requirements are less than they are for an outright long or short position. (To keep risk in line with profit potential, the spreader must have considerable knowledge of the relationship between the contracts that are being used, otherwise there is the possibility of incurring a loss in both long and short positions.)

Users of Long Term Interest Rate Futures

Government bond futures contracts are used by:

Portfolio managers

One of the main users of long-term interest rate futures contracts is a pension fund manager. These managers are responsible for creating an asset portfolio whose value coincides with or exceeds the value of a given schedule of liabilities (anticipated payouts to retirees), and whose duration or interest rate sensitivity is the same as the liabilities. Fund managers refer to this as immunizing their liabilities against a certain range of interest rate movements.

Bond traders

The long-term interest rate futures add another tool to the bond trader's portfolio. They can be used to hedge an existing portfolio or adjust the duration of the existing portfolio. Traders can adjust their view and the portfolio's position quickly by using the futures market.

Bond issuers and underwriters

Very often corporations know in advance that they will be issuing debt at some point in the near future. One example would be future project funding. The corporation could issue the debt today and invest the proceeds until such time that the funds are actually required. By using the interest rate futures contract the risk free component of the issuance can be locked in.

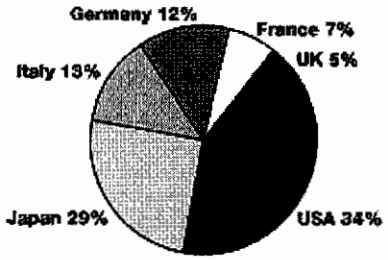
The corporation would sell futures contracts. If interest rates rose between now and the time of debt issuance, the cost of the debt would increase. However this would be offset by a gain on the futures transaction. When the company closes its futures position the price will have

fallen due to an increase in yields. This gain could be used to offset the increased expense on the debt.

Swap book managers
One of the tools swap book managers use to manage their interest rate risk is bond futures. Swap rates normally trade at fairly stable spreads above government bond rates. Although the swap book is taking "basis risk" by hedging swap rates with government bond rates through bond futures, the greatest source of uncertainty is the underlying government bond rate.

Long-term interest rate speculators
Futures provide speculators a very convenient, highly liquid, and low transaction cost platform for taking positions.

Major Government Bond Futures Exchanges



Relative Size of Major Government Bond Markets

The major bond futures exchanges align closely with the world's major government bond markets, shown above.

Open Markets
By providing a continuous flow of price information, futures markets perform an important economic function: price discovery. Futures exchanges operate as free markets where forces influencing price are brought together in an open outcry auction. The exchange does not set prices for financial futures or options on futures contracts, it simply records these prices.

Future Settlement
After the prices are recorded, they are disseminated to the world wide financial community. In the cash market, delivery or sale of the product can be immediate or usually within five business days following the transaction. Participants in futures markets, however, agree to buy or sell a specific amount and type of commodity at some date in the future that may be as long as a year or two away. Thus, the transaction is a *futures* trade.

Delivery
A seller who wishes to make delivery of the commodity underlying the futures contract or a buyer who wishes to receive the actual financial instrument may do so. However, very few

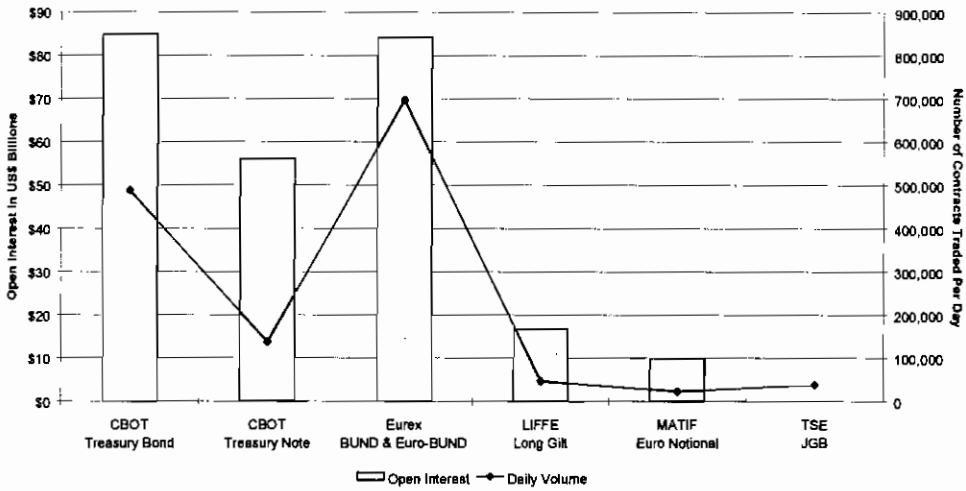
actually do. At financial futures exchanges, typically only about three percent of all contracts are settled by the buyer taking or the seller making delivery of the underlying bond.

Major Futures Exchanges
The biggest futures exchanges trading government bond futures contracts include:

- Chicago Board of Trade (CBOT)
  - U.S. Treasury Bond Futures
  - 10-Year U.S. Treasury Note Futures
  - Five-Year Treasury Note Futures
  - Two-Year Treasury Note Futures
- London International Financial Futures and Options Exchange (LIFFE)
  - Long Gilt Future
  - Five Year Gilt Future
  - Italian Government Bond (BTP) Future
  - Japanese Government Bond (JGB) Future
  - German Government Bond (Bund) Future
- Eurex
  - Euro-BUND Futures
  - Euro-BOBL Futures
  - Euro-BUXL Futures
  - Euro-SCHATZ Futures
  - Euro-Jumbo Pfandbrief Futures
- Marché à Terme International de France (MATIF)
  - 30-year E-Bond
  - Euro Notional (10-year bond)
  - Euro All Sovereigns (10-year bond)
  - Euro 5-year
  - 2-year E-Note
- Tokyo Stock Exchange (TSE)
  - 10-year Japanese Government Bond (JGB) Futures
  - T-Bond Futures

Trading volumes at these exchanges reflect the size of the underlying government bond markets in each case:

Major Bond Futures Contracts
16 February 1999



Chicago Board of Trade

Chicago Board of Trade (CBOT)

The Chicago Board of Trade (CBOT), established in 1848, is the world's oldest and largest futures and options exchange. More than 3,600 CBOT members trade 57 different futures and options products at the CBOT, resulting in 1996 annual trading volume of 222.4 million contracts.

At its inception, the CBOT traded only agricultural futures contracts -- such as wheat, corn and soybeans. In 1975, the CBOT expanded to include financial contracts, including the U.S. Treasury Bond futures contract that is now one of the world's most actively traded contracts. The CBOT expanded again in 1982, when options on futures contracts were introduced. The newest CBOT contract is the German Bund future, which is part of an agreement with the London International Financial Futures Exchange.

The primary method of trading at the CBOT is open outcry, during which traders meet face-to-face in trading pits to buy and sell futures contracts. The CBOT recently inaugurated its new $182 million financial trading floor, the largest trading floor in the world, to accommodate expanding business in open outcry trading.

The CBOT also manages its rapidly growing electronic trading system called Project A.

The Function of the Futures Market

By providing a continuous flow of price information, futures markets perform an important economic function: price discovery. The Chicago Board of Trade operates as a free market where forces influencing price are brought together in an open outcry auction. The CBOT does not set prices for financial futures or options on futures contracts, it simply records these prices.

After the prices are recorded, they are disseminated to the worldwide financial community. Unlike the cash market, where delivery or sale of the product can be immediate (or usually within five business days following the transaction), participants in futures markets agree to buy or sell a specific amount and type of commodity at some date in the future that may be as long as a year or two away. Thus, the term *futures*.

Margin

When entering into a futures transaction, either as buyer or seller, an initial cash deposit, called margin, must be posted to secure the contract. Futures margins are not the same as margin to purchase stock.

A futures margin represents a good-faith deposit or performance bond to guarantee a participant's performance of contractual obligations. Buyers and sellers of futures contracts must deposit some percentage of a futures contract's full value. In the case of CBOT financial futures, margins are typically less than 3 percent of the contract's full value.

On the other hand, a stock margin represents a down payment for the purchase of equities and currently, for most investors, must be at least 50 percent of the market value of the stock. The balance of the purchase price then is borrowed from a securities firm by the investor who must later repay the loan with interest, generally one or more percentage points above the prime rate of interest.

As long as the futures contract has not been offset or liquidated by an equal and opposite (offsetting) transaction, both buyer and seller are obligated to pay any losses or may receive any gains on a daily basis. All futures positions are adjusted (market-to-market) after the end of each trading session to reflect the day's net gains or losses.

If price movements create a loss that depletes the martin below the level needed to maintain the open position, additional funds must be deposited before the start of the next day's trading to bring the account back to the original predetermined level.

In very volatile markets, additional funds may be required while trading is in progress. This is known as variation margin and it requires that funds be posted to the account within an hour, or when reasonably possible.

If maintenance or variation margin calls are not met by the customer, the futures position is closed.

If maintenance or variation margin calls are not met by the customer, the futures position is closed.

Margin requirements for each financial futures contract are set by the Board of Directors of the exchange at a level high enough to guarantee the financial integrity of the marketplace without unduly restricting market participation. Futures margins can be, and are, changed as often as necessary to reflect the activity of a given financial futures contract.

Although the exchange sets margin requirements, the brokerage house or commission firm that executes the order for the client has its own margin requirements that normally exceed those set by the Chicago Board of Trade.

Delivery

A seller who wishes to make delivery of the commodity underlying the futures contract or a buyer who wishes to receive the actual financial instrument may do so. However, very few actually do. At the Chicago Board of Trade, only about three percent of all contracts are settled by the buyer taking or the seller making delivery of the commodity itself.

Information provided is taken from sources believed to be reliable but is not guaranteed as to its accuracy or completeness. The Rules and Regulations of the Chicago Board of Trade and/or the Mid-America Commodity Exchange should be consulted as the authoritative source for information, rules and contract specifications.

London International Financial Futures and Options Exchange

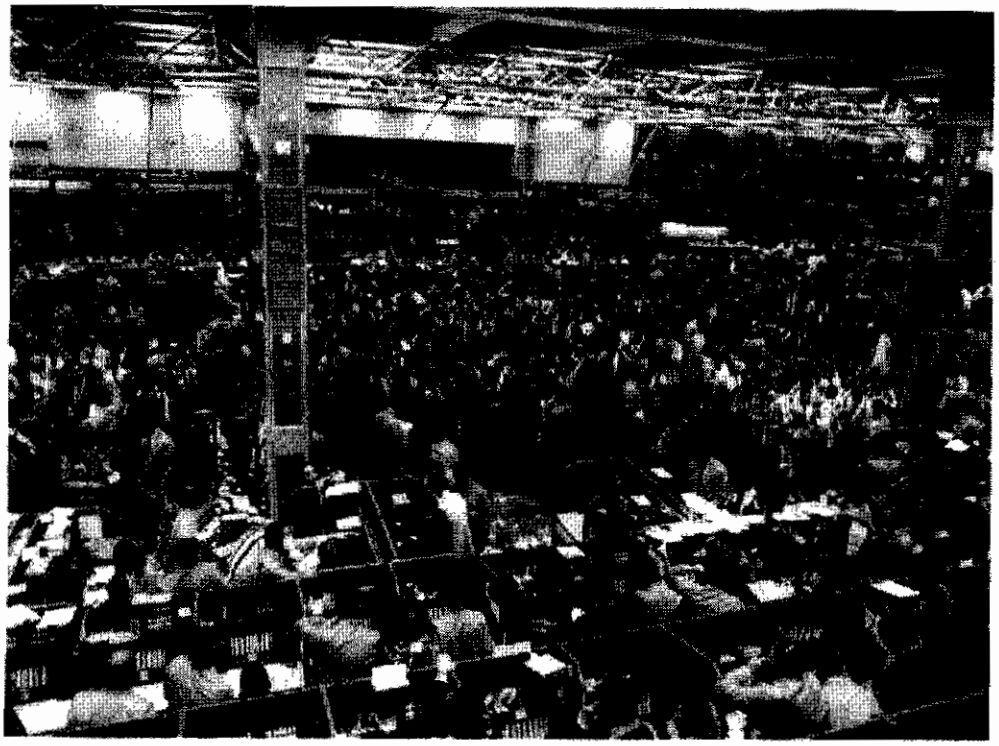
LIFFE is an exchange where people trade financial risk. Those who do not want to take financial risks transfer them to people who have the appetite for them and the ability to control them.

Financial risks include the danger that share prices might change, government bond or other asset prices might rise or fall, or interest rates might go up or down. Many people face risks like this.

Because of LIFFE's market place, banks and other financial institutions can:

- Offer fixed rate mortgages to homeowners;
- Help companies protect investment programs and jobs against the danger that higher interest rates might make them unprofitable;
- Protect their own assets - for example, pension funds can improve their performance;
- Offer medium term fixed rate finance to small businesses;
- Supply new and innovative savings products to their customers.

Such is the demand for these services that LIFFE has grown by over 40% a year since it was founded in 1982 and is now one of the top three in the world. It earns £700m in invisible earnings for Britain and provides 25,000 jobs.



The Trading Mechanism

The LIFFE market operates an open outcry system of floor trading that is supplemented by the APT screen based trading system. APT, which is the only system in the world that replicates the open outcry method of trading on screen, supplies an electronic audit trail of events in the trading process. Rules and procedures governing the accurate recording of trade related information ensure that an equivalent audit trail can be constructed for trades executed on the floor. The audit trails are supported by vigilant supervision and constantly upgraded technology.

Trading Badges and Jackets

The trading jackets are one of the instantly noticeable features of the LIFFE market. In a crowded pit they are an invaluable aid to counterparties, booth staff and Exchange officials for identifying the trader and the member to whom the trader is registered.

Similarly, trading badges worn by each trader provide detailed identification and also show important information including:

- a photograph of the trader;

- the individual trader's three letter identifying mnemonic;
- the trading permit that the trader is using, demonstrating that the member firm to whom he/she is registered holds or leases the relevant LIFFE permit; and the categories of LIFFE contract that the trader is qualified to trade.

Hand Signals

The Rules and Trading Procedures of LIFFE require that all transactions on the floor are conducted by open outcry. As well as announcing their bids and offers to the pit orally, traders clarify their intentions using hand signals. These signals may be used to indicate whether the trader is buying or selling, the number of contracts that the trader wishes to buy or sell, and the trader's bid or offer price. The use of hand signals helps to ensure that the trading process is both swift and accurate.

Audio and Video Surveillance

All LIFFE pits are subject to video surveillance throughout the trading day. All telephones on the trading floor are audio logged by the Exchange. The audio and video logs are synchronised with the central clock which drives the time stamp machines used to print the time stamps that are required on trader cards and order slips.

The video recordings have come to form a useful element of the audit trail for members themselves and for the Exchange. The Exchange is currently in the process of enhancing its video logging facilities to allow all floor booths to be videoed and picture quality to be enhanced (with more effective zoom and freeze-frame facilities).

Order Routing on the Trading Floor

All orders must be time stamped when they are received in the booth, and when they are (partially or fully) filled. Trader cards, showing the details of each trade executed by a trader, must also be time stamped.

Once an order has been time stamped it is passed from the booth to a pit trader, either by hand signals, or on paper via a runner. The pit trader indicates his willingness to buy or sell to the pit by a combination of voice and hand signals. Once he has traded the order in the pit, he records the price, contract and counterparty's identity on a trader card. The trade details are passed to the booth, either by signal or by a runner, and the customer is told that his order has been executed.

Finally, the trader card and order slip are time stamped again in the member's administration booth, and details of the trade are entered into the Trade Registration System (TRS).

Locals

An individual registered trader who trades for his own account is known as a local. Locals provide liquidity to the market by buying and selling futures and options contracts on a speculative basis throughout the trading day. LIFFE currently has approximately five hundred registered locals.

Market Makers

Equity options are traded in a competing market maker environment. Members who wish to act as market makers in specific options must enter into a formal agreement with LIFFE and seek to be assigned as Level 1 or Level 2.

Level 2 market makers are required to be present on the market floor at all times, Level 1 market makers are only required to be present for a specified number of hours on a minimum number of days (currently 210) each year. Both Level 1 and Level 2 market makers can additionally choose to act as nominated market makers in a limited number of those options in which they are not assigned. Nominated market makers fulfill less onerous obligations as they are required to quote only when requested to do so by an exchange official.

While each individual equity option is expected to have the support of a minimum of three market makers, at least one of whom is assigned, the Exchange imposes no upper limit on the number of market makers in an individual equity option.

Observers and Price Reporters

Each trading pit is overseen by one or more LIFFE observers. As well as monitoring trading to ensure that it is carried out in accordance with the Exchange Rules and Trading Procedures, observers are continually monitoring the price levels at which contracts are being traded, and passing this information to price reporters via microphones.

The price reporters enter prices which update both the display on the Exchange floor boards and the feeds to quote vendor systems. In this way, price changes during trading hours appear on price quotation boards located around the trading floor and are also disseminated around the world through quote vendors.

Observers also monitor trading on APT from the APT control room based in the Exchange.

Capacity

LIFFE members, and registered traders, currently have dual capacity status. The Capacity Working Party (reporting to Membership and Rules Committee) is examining the potential conflicts of interest, and the ways which these are monitored, that can arise from the variety of capacities in which members and their registered staff can currently conduct business on the market eg on behalf of house, member and non-member clients, related party clients and their personal accounts. The principal objective is to determine whether any changes to the Rules are required in order to maintain the regulatory objective of overall investor protection through seeking a different balance in some or all contracts between the liquidity generated by multiple capacity and the need to monitor its potential abuse.

The Automated Pit Trading System (APT)

APT is a screen based trading system used by LIFFE to supplement floor based trading. Introduced in November 1989, APT uses highly advanced technology and state of the art color display methods to allow the open outcry pit trading mechanism to be represented electronically. Over 1000 traders are qualified to operate the approximately 125 workstations that comprise the APT network.

APT is used to extend the trading day for the major futures contracts as well as to provide a daytime trading environment for non floor traded products (currently only the Japanese Government Bond Futures contract is traded on APT during the day).

Trades executed on APT are fed directly into TRS for registration.

CBOT • LIFFE

A LINKAGE OF LEADERS

CBOT–LIFFE Link

The introduction of Treasury bond futures by the Chicago Board of Trade (CBOT®) in 1977 revolutionized financial markets around the globe. Institutional investors were provided with the tools to manage interest rate volatility and to implement many common fixed income portfolio management decisions. The establishment of the London International Financial Futures and Options Exchange (LIFFE) in 1982 extended the risk management applications of fixed income futures to the European business day.

Today's financial markets are global. Institutional investors must have easy access to risk management vehicles such as international government bond futures and options, in order to hedge their exposure to global interest rates properly and to respond quickly to the opportunities associated with interest rate volatility. In response to the global nature of today's markets, the CBOT and LIFFE have embarked on an historic open outcry trading initiative, the CBOT-LIFFE Link, giving investors around the world the opportunity to trade the benchmark bond futures and options contracts of Europe and the United States during their own business hours.

This unique agreement between the CBOT and LIFFE combines the strength, integrity and innovative spirit of both exchanges, the largest in the world and the largest outside the United States. Each exchange is bringing its most active government bond products to the Link in order to signal a mutual commitment to open outcry trading and to provide efficient and cost-effective solutions to a dynamic financial landscape.

Designated Link Products

Under the terms of this innovative trading Link, the CBOT will trade LIFFE's major European bond futures and options contracts after the London business day. In return, LIFFE will trade CBOT Treasury bond and note futures and options contracts prior to the U.S. business day. The futures and options contracts incorporated by the Link are identical to and fungible with the existing contracts traded on the home exchange.

At the commencement of the Link, LIFFE will trade futures and options on US Treasury bonds. In return, the CBOT will trade Bund futures and options. During subsequent stages of the Link, 10-year and 5-year Treasury note futures and options will begin trading on the LIFFE floor and the CBOT will introduce trading in UK Government Bond (Long Gilt) and Italian Government Bond (BTP) futures and options on its floor.

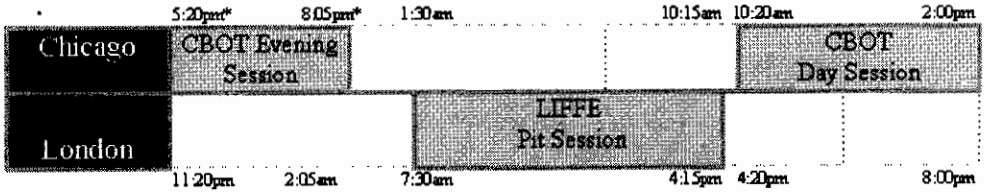
Link Trading Hours

The trading hours for Bund futures and options on the CBOT are:

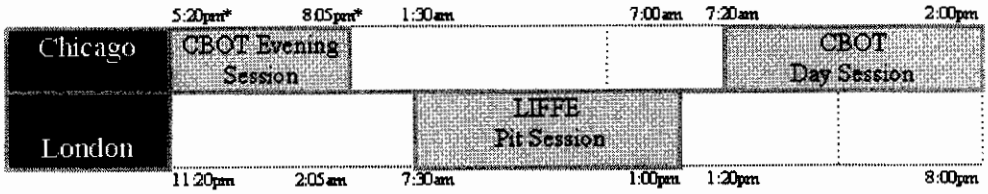
Chicago time	**London time**
10:20 am to 2:00 pm	4:20 pm to 8:00 pm

LIFFE products will also trade during CBOT evening session hours of 5:20 pm to 8:05 pm (Chicago time), i.e. 11:20 pm to 2:05 am (London time)[1].

LIFFE Bond Futures Contracts on CBOT



T-Bonds Futures and Options on LIFFE



[1] The CBOT evening session will be open from 6:20 pm to 9:05 pm (Chicago time), i.e. 12:20 am to 3:05 am London time during Central Daylight Saving Time.

Eurex

Eurex was originally created in December 1996 as a joint venture project between Deutsche Börse AG and the Swiss Stock Exchange, Schweizer Börse, and formally established in 1998 following the merger of DTB Deutsche Terminbörse (German Options and Futures Exchange) and SOFFEX (Swiss Options and Financial Futures Exchange). The object of this merger was the development and realization of a joint platform for the two options exchanges as well as the harmonization of their services and product ranges.

Eurex offers a truly international market. It is the only fully computerized trading and clearing platform with worldwide access availability which provides a uniform range of standardized, innovative products and services - founded on a harmonized regulatory framework basis.

The number of Eurex-members continues to grow: at the end of December 2001, there were a total of 427 members with a trading volume encompassing 674 million contracts. Eurex not only forms the core of European trading in derivatives, it became the world's largest derivates market in January 1999.[2]

Advantages at a Glance

- Flexibility
  - ◊ Possibility of location-independent trading access
- Liquidity
  - ◊ More than 140 exchange participants
  - ◊ Market-makers quote binding bid and offer prices
  - ◊ Integrated combination order book for futures
- Transparency
  - ◊ Insight of the ten best bid and offer prices, the corresponding sizes as well as of other market-relevant data.
- Security
  - ◊ Computer-supported trading supervision
  - ◊ Every single keystroke is logged and may be reconciled

[2] Taken from the Eurex web site: http://deutsche-boerse.com/INTERNET/EXCHANGE/index_e.htm

- ◊ Controlled market circumstances

- Speed
  - ◊ Buying or selling by a simple keystroke
  - ◊ Response times below 1 second

Contract Specifications

LIFFE Long Gilt Future

Unit of trading:	£100,000 nominal value notional Gilt with 7% coupon
Delivery months:	March, June, September, December
First notice day:	Two business days prior to the first day of the delivery month Last notice day: First business day after the Last Trading Day
Delivery day:	Any business day in delivery month (at seller's choice)
Last trading day:	11.00 - Two business days prior to the last business day in the delivery month
Quotation:	Per £100 nominal
Tick size & value:	0.01 - £10
Trading hours:	08.00 - 16.15
APT trading hours:	16.22 - 18.00

Contract standard:
Delivery may be made of any Gilts on the List of Deliverable Gilts in respect of a delivery month, as published by the Exchange on or before the tenth business day prior to the First Notice Day of such delivery month. Holders of long positions on any day within the Notice Period may be delivered against during the delivery month. All Gilt issues included in the List will have the following characteristics.

Deliverable Gilt Characteristics

1. Having terms as to redemption such as provide for redemption of the entire Gilt issue in a single installment on the maturity date falling not earlier than 8.75 years from, and not later than 13 years from, the first day of the relevant delivery month;
2. Having no terms permitting or requiring early redemption;
3. Bearing interest at a single fixed rate throughout the term of the issue payable in arrears semi-annually (except in the case of the first interest payment period which may be more or less than six months);
4. Being denominated and payable as to the principal and interest only in pounds and pence;

5. Being fully paid or, in the event that the Gilt issue is in its first period and is partly paid, being anticipated by the Board to be fully paid on or before the Last Notice day of the relevant delivery month;
6. Not being convertible;
7. Not being in bearer form;
8. Having been admitted to the Official List of the London Stock Exchange; and
9. Being anticipated by the Board to have on one or more days in the delivery month an aggregate principal amount outstanding of not less than £1.5 billion, which, by its terms and conditions, if issued in more than one tranche or tap or issue, is fungible.

Exchange Delivery Settlement Price (EDSP)
The LIFFE market price at 11.00 on the second business day prior to Settlement Day. The invoicing amount in respect of each Deliverable Gilt is to be calculated by the price factor system. Adjustment will be made for full coupon interest accruing as at Settlement Day.

Basis Trading Facility (BTF)
This allows basis trades to be registered ex-pit and without execution risk. The facility is available for LIFFE's Long Gilt future against any conventional, non-callable UK gilt having a minimum size of £1.5 billion and minimum time to maturity of two years from the first calendar day of the delivery month.

Eurex Bund Future[3]

Contract Standard
A notional long-term debt instrument issued by the German Federal Government with a term of 8½ to 10½ years and an interest rate of 6 percent.

Contract Size
DEM 250,000

Settlement
A delivery obligation arising out of a short position in a BUND Futures contract may only be satisfied by the delivery of specific debt securities - namely, German Federal Bonds (Bundesanleihen) with a remaining term upon delivery of 8½ to 10½ years. The debt securities must have a minimum issue amount of DEM 4 billion or, in the case of new issues as of 1.1.1999, 2 billion euros.

Quotation
In a percentage of the par value, carried out two decimal places.

Minimum Price Movement
0.01 percent, representing a value of DEM 25.

[3] Due to the pending conversion of DEM into the Euro, the last tradable expiration month is March, 1999.

Delivery Day
The 10th calendar day of the respective delivery month, if this day is an exchange trading day; otherwise, the immediately following exchange trading day.

Delivery Months
The three successive months within the cycle March, June, September and December.

Notification
Clearing Members with open short positions must notify Eurex which debt instruments they will deliver, with such notification being given by the end of the Post-Trading Period on the last trading day in the delivery month of the futures contract.

Last Trading Day
Two exchange trading days prior to the delivery day of the relevant delivery month. Trading in the contract for this delivery month ceases at 12:30 p.m. CET.

Daily Settlement Price
The volume-weighted average price of the five last trades of the day, provided they are not older than 15 minutes - or, if more than five trades have occurred during the final minute of trading, then the volume-weighted average price of all trades that occurred during that period.

Final Settlement Price
The volume-weighted average price of the last ten trades, provided they are not older than 30 minutes - or, if more than ten trades have occurred during the final minute of trading, then the volume-weighted average price of all trades that occurred during that period - is used to determine the final settlement price. The final settlement price is determined at 12:30 p.m. CET on the last trading day.

Trading Hours
8:00 a.m. until 7:00 p.m. CET.

Eurex Euro-BUND Futures

Contract Standard
A notional long-term debt instrument issued by the German Federal Government with a term of 8½ to 10½ years and an interest rate of 6 percent.

Contract Size
EUR 100,000

Settlement
A delivery obligation arising out of a short position in a Euro-BUND Futures contract may only be satisfied by the delivery of specific debt securities - namely, German Federal Bonds (Bundesanleihen) with a remaining term upon delivery of 8½ to 10½ years. The debt securities must have a minimum issue amount of DEM 4 billion or, in the case of new issues as of 1.1.1999, 2 billion euros.

Quotation
In a percentage of the par value, carried out two decimal places.

Minimum Price Movement
0.01 percent, representing a value of EUR 10.

Delivery Day
The 10th calendar day of the respective delivery month, if this day is an exchange trading day; otherwise, the immediately following exchange trading day.

Delivery Months
The three successive months within the cycle March, June, September and December.

Notification
Clearing Members with open short positions must notify Eurex which debt instruments they will deliver, with such notification being given by the end of the Post-Trading Period on the last trading day in the delivery month of the futures contract.

Last Trading Day
Two exchange trading days prior to the delivery day of the relevant delivery month. Trading in the contract for this delivery month ceases at 12:30 p.m. CET.

Daily Settlement Price
The volume-weighted average price of the five last trades of the day, provided they are not older than 15 minutes - or, if more than five trades have occurred during the final minute of trading, then the volume-weighted average price of all trades that occurred during that period.

Final Settlement Price
The volume-weighted average price of the last ten trades, provided they are not older than 30 minutes - or, if more than ten trades have occurred during the final minute of trading, then the volume-weighted average price of all trades that occurred during that period - is used to determine the final settlement price. The final settlement price is determined at 12:30 p.m. CET on the last trading day.

Trading Hours
8:00 a.m. until 7:00 p.m. CET.

CBOT Long Bond Future

Trading Unit
One U.S. Treasury bond having a face value at maturity of $100,000 or multiple thereof

Deliverable Grades
U.S. Treasury bonds that, if callable, are not callable for at least 15 years from the first day of the delivery month or, if not callable, have a maturity of at least 15 years from the first day of the delivery month. The invoice price equals the futures settlement price times a conversion factor plus accrued interest. The conversion factor is the price of the delivered bond ($1 par value) to yield 8 percent.

Price Quote
Points ($1,000) and thirty-seconds of a point; for example, 80-16 equals 80 16/32

Tick Size
1/32 of a point ($31.25/contract); par is on the basis of 100 points

Daily Price Limit
3 points ($3,000/contract) above or below the previous day's settlement price (expandable to 4 1/2 points). Limits are lifted the second business day preceding the first day of the delivery month.

Contract Months
Mar, Jun, Sep, Dec

Delivery Method
Federal Reserve book-entry wire-transfer system

Last Trading Day
Seventh business day preceding the last business day of the delivery month

Last Delivery Day
Last business day of the delivery month

Trading Hours
Open Outcry: 7:20 a.m. - 2:00 p.m. Chicago time, Mon-Fri.

Project A®: Afternoon session 2:15 - 4:30 p.m., Chicago time, Mon-Thu
Overnight session 6:00 p.m. - 5:00 a.m., Chicago time, Sun-Thu
Day session 5:30 a.m. - 2:00 p.m., Chicago time, Mon-Fri.

Trading in expiring contracts closes at noon on the last trading day.

Bond Futures Prices

Deliverable Bonds

The list of bonds which fits the description given above for each contract changes from time to time as new bonds are issued and as older bonds become shorter than the minimum maturity described above.

The number of deliverable issues is one of the biggest question marks surrounding the various contracts traded on the major exchanges. The list of deliverable bonds ranges from about 38 different issues for the CBOT's Treasury bond contract in February 1999, to four issues for the March 1999 Eurex Bund contract and only three for the March 1999 Eurex Euro-Bund contract.

The deliverable bond cheapest to buy in the market is the key determinant of a bond future contract's price. It is thus watched closely.

In general terms, bonds that are valued most highly by the futures exchange's settlement method are the cheapest bonds to deliver against the futures contract. The cheapest bond to deliver changes from time to time, normally as a function of changing bond yields or a change in the slope of the yield curve.

Bonds that are deliverable but not generally desired by bond investors tend to move up the list of cheapest to deliver bonds because their prices are discounted in the cash bond market. Under current market conditions (long-term interest rates at historical cyclical lows) this is true for bonds issued earlier, which have very high coupons. In a few years, if long-term yields have risen again, bonds being issued now will be available at a discount in the cash market, and so will likely remain somewhat more desirable.

When bond yields are low, as they still are in 1997, bonds with shorter modified duration (henceforth referred to simply as *duration*) tend to be cheaper to deliver. This is because market prices for shorter duration bonds rise relatively less than market prices for longer duration bonds as rates fall.

Higher coupons shorten duration. Thus, the cheapest to deliver bonds when yields in the market are low will be those bonds with the highest coupons and/or shortest maturities. This is clearly evident with the deliverable bonds into the long Treasury bond contract on the CBOT.

As of February 1999, the list of deliverable bonds for the March 1999 Treasury bond futures contract stood as follows:

Deliverable Bonds and Conversion Factors, CBOT Treasury Bond Futures

	Coupon	Maturity	Issue Date	O/S	Mar-99	Jun-99	Sep-99	Dec-99
1	5 1/4	16-Nov-98	15-Nov-28	10	0.6902	0.6908	0.6916	0.6922
2	5 1/4	16-Feb-99	15-Feb-29	10.01	0.6894	0.6902	0.6908	0.6916
3	5 1/2	17-Aug-98	15-Aug-28	10	0.7189	0.7196	0.7201	0.7209
4	6	15-Feb-96	15-Feb-26	12	0.7805	0.7813	0.7817	0.7825
5	6 1/8	17-Nov-97	15-Nov-27	10	0.7907	0.7910	0.7917	0.7921
6	6 1/8	17-Feb-98	15-Nov-27	11.18	0.7907	0.7910	0.7917	0.7921
7	6 1/4	16-Aug-93	15-Aug-23	11	0.8137	0.8145	0.8150	0.8159
8	6 1/4	15-Feb-94	15-Aug-23	11.05	0.8137	0.8145	0.8150	0.8159
9	6 3/8	15-Aug-97	15-Aug-27	10	0.8189	0.8195	0.8198	0.8204
10	6 1/2	15-Nov-96	15-Nov-26	10	0.8342	0.8345	0.8351	0.8353
11	6 5/8	18-Feb-97	15-Feb-27	10.45	0.8475	0.8480	0.8482	0.8488
12	6 3/4	15-Aug-96	15-Aug-26	10	0.8620	0.8625	0.8628	0.8633
13	6 7/8	15-Aug-95	15-Aug-25	11.5	0.8771	0.8777	0.8779	0.8784
14	7 1/8	16-Feb-93	15-Feb-23	9.3	0.9074	0.9079	0.9081	0.9086
15	7 1/8	17-May-93	15-Feb-23	8.26	0.9074	0.9079	0.9081	0.9086
16	7 1/4	15-May-86	15-May-16	18.82	0.9310	0.9313	0.9319	0.9323
17	7 1/4	17-Aug-92	15-Aug-22	10.01	0.9212	0.9217	0.9218	0.9223
18	7 1/2	15-Nov-86	15-Nov-16	18.86	0.9533	0.9535	0.9540	0.9541
19	7 1/2	15-Aug-94	15-Nov-24	11.01	0.9460	0.9459	0.9463	0.9463
20	7 5/8	15-Nov-92	15-Nov-22	10.3	0.9605	0.9605	0.9608	0.9608
21	7 5/8	15-Feb-95	15-Feb-25	11.02	0.9592	0.9595	0.9594	0.9597
22	7 7/8	15-Feb-91	15-Feb-21	11.01	0.9870	0.9873	0.9871	0.9874
23	8	15-Nov-91	15-Nov-21	32.33	1.0000	0.9998	1.0000	0.9998
24	8 1/8	15-Aug-89	15-Aug-19	20.01	1.0122	1.0124	1.0121	1.0122
25	8 1/8	15-May-91	15-May-21	11.75	1.0128	1.0126	1.0127	1.0125
26	8 1/8	15-Aug-91	15-Aug-21	12.01	1.0127	1.0128	1.0126	1.0127
27	8 1/2	15-Feb-90	15-Feb-20	10.06	1.0500	1.0500	1.0495	1.0495
28	8 3/4	15-May-87	15-May-17	18.19	1.0709	1.0702	1.0700	1.0693
29	8 3/4	15-May-90	15-May-20	10.01	1.0757	1.0751	1.0750	1.0744
30	8 3/4	15-Aug-90	15-Aug-20	21.01	1.0758	1.0757	1.0751	1.0750
31	8 7/8	15-Aug-87	15-Aug-17	14.02	1.0830	1.0827	1.0820	1.0817
32	8 7/8	15-Feb-89	15-Feb-19	19.25	1.0859	1.0857	1.0850	1.0847
33	9	15-Nov-88	15-Nov-18	9.03	1.0979	1.0972	1.0968	1.0961
34	9 1/8	15-May-88	15-May-18	8.71	1.1089	1.1081	1.1077	1.1068
35	9 1/4	15-Feb-86	15-Feb-16	7.27	1.1140	1.1134	1.1123	1.1117
36	9 7/8	15-Nov-85	15-Nov-15	6.9	1.1701	1.1686	1.1676	1.1660
37	10 5/8	15-Aug-85	15-Aug-15	7.15	1.2361	1.2346	1.2325	1.2308
38	11 1/4	15-Feb-85	15-Feb-15	12.67	1.2879	1.2858	1.2832	1.2810

If we re-order the above list with the cheapest to deliver bond at the top of the list, we can make some observations:

Bond	Coupon	Maturity	Price	CF	Yield	Duration	Net Basis
38	11 8/32	15-Feb-15	160 8/32	1.2879	5.527%	9.16	-1.9
37	10 20/32	15-Aug-15	154 4/32	1.2361	5.567%	9.42	-12.8
36	9 28/32	15-Nov-15	146 9/32	1.1701	5.583%	9.48	-25.7
35	9 8/32	15-Feb-16	139 23/32	1.1140	5.597%	9.84	-39.1
28	8 24/32	15-May-17	135 13/32	1.0709	5.621%	10.19	-73.8
16	7 8/32	15-May-16	118 1/32	0.9310	5.604%	10.25	-75.7
31	8 28/32	15-Aug-17	137 3/32	1.0830	5.623%	10.41	-79.2
18	7 16/32	15-Nov-16	120 30/32	0.9533	5.619%	10.34	-79.7
34	9 4/32	15-May-18	140 25/32	1.1089	5.627%	10.42	-94.6
33	9	15-Nov-18	139 26/32	1.0979	5.632%	10.60	-107.5
32	8 28/32	15-Feb-19	138 18/32	1.0859	5.635%	10.87	-115.0
24	8 4/32	15-Aug-19	129 30/32	1.0122	5.642%	11.20	-132.8
27	8 16/32	15-Feb-20	134 29/32	1.0500	5.642%	11.25	-141.3
30	8 24/32	15-Aug-20	138 12/32	1.0758	5.645%	11.33	-149.5
29	8 24/32	15-May-20	138 12/32	1.0757	5.629%	11.10	-150.4
22	7 28/32	15-Feb-21	127 29/32	0.9870	5.644%	11.70	-168.5
25	8 4/32	15-May-21	131 5/32	1.0128	5.647%	11.52	-170.1
26	8 4/32	15-Aug-21	131 11/32	1.0127	5.647%	11.76	-176.1
23	8	15-Nov-21	129 31/32	1.0000	5.643%	11.69	-183.2
17	7 8/32	15-Aug-22	120 26/32	0.9212	5.640%	12.29	-203.8
20	7 20/32	15-Nov-22	125 26/32	0.9605	5.638%	12.06	-207.6
14	7 4/32	15-Feb-23	119 17/32	0.9074	5.631%	12.47	-217.8
15	7 4/32	15-Feb-23	119 17/32	0.9074	5.631%	12.47	-217.8
7	6 8/32	15-Aug-23	108 9/32	0.8137	5.623%	12.93	-231.1
8	6 8/32	15-Aug-23	108 9/32	0.8137	5.623%	12.93	-231.1
19	7 16/32	15-Nov-24	125 25/32	0.9460	5.597%	12.61	-264.7
13	6 28/32	15-Aug-25	117 9/32	0.8771	5.613%	13.17	-267.0
21	7 20/32	15-Feb-25	127 21/32	0.9592	5.594%	12.82	-271.8
4	6	15-Feb-26	105 27/32	0.7805	5.579%	13.66	-285.4
12	6 24/32	15-Aug-26	116 8/32	0.8620	5.586%	13.46	-293.9
10	6 16/32	15-Nov-26	112 27/32	0.8342	5.583%	13.42	-295.9
11	6 20/32	15-Feb-27	114 24/32	0.8475	5.578%	13.62	-303.7
9	6 12/32	15-Aug-27	111 13/32	0.8189	5.572%	13.83	-310.6
5	6 4/32	15-Nov-27	108 3/32	0.7907	5.557%	13.81	-317.2
6	6 4/32	15-Nov-27	108 3/32	0.7907	5.557%	13.81	-317.2
3	5 16/32	15-Aug-28	100 4/32	0.7189	5.491%	14.52	-347.8
1	5 8/32	15-Nov-28	97 31/32	0.6902	5.387%	14.62	-393.6
2	5 8/32	15-Feb-29	99 1/32	0.6894	5.315%	14.95	-430.7

Duration ranges from only 9.16 for the cheapest to deliver to 14.95. Duration appears to be the principal determinant of which bond is cheaper to deliver, due to the low level of yields in the market. In addition, bonds with very high coupons trade at very high premiums above par. Many investors are loath to spend 150% of par or more to buy a bond.

When bond yields are relatively high (above 8%), the reverse is true. Bonds with relatively longer duration will tend to be the cheaper bonds to deliver. The market prices of longer

duration bonds tend to fall relatively faster than the market prices of shorter duration bonds as yields rise. They are thus relatively cheaper to buy and therefore cheaper to deliver.

Duration is not the only factor in determining which bonds are cheaper to deliver. Bonds' prices relative to each other are affected by other variables such as liquidity, whether a bond is callable, and perceived differential credit quality among eligible "government" issuers. In general, when bonds have the same duration, the bond with the higher yield will have the lower price, and therefore be cheaper to deliver. Its price is lower because it is less desirable to investors for one of the reasons listed above.

List of Deliverable Gilts

Long Gilt contract (7%) coupon - price factors and accrued interest

Delivery month: March 1999

Gilt	Coupon	Redemption	Price factor	Daily accrued	Initial accrued
1. Treasury	7.25	7 Dec 07	1.0160769	19.9176	1,653.16
2. Treasury	9.00	13 Oct 08	1.1381874	24.7253	3,412.09
3. Treasury	5.75	07 Dec 09	0.9064701	15.7967	1,311.13
4. Treasury	6.25	25 Nov 10	0.9406383	17.2652	1,640.19
5. Conversion	9.00	12 Jul 11	1.1638010	24.8619	1,168.51

Eurex Euro-Bund Future March 1999

Deliverable Bond ISIN Code	Coupon Rate (%)	Maturity Date	Conversion Factor
DE0001135051	5.250	04.01.08	0.949788
DE0001135077	4.750	04.07.08	0.912935
DE0001135093	4.125	04.07.08	0.869567

Eurex Bund Future March 1999

Deliverable Bond ISIN Code	Coupon Rate (%)	Maturity Date	Conversion Factor
DE0001135051	5.250	04.01.08	0.949788
DE0001135077	4.750	04.07.08	0.912935
DE0001135093	4.125	04.07.08	0.869567
DE0001135101	3.750	04.01.09	0.837267

Determining which bond is the cheapest to deliver requires an understanding of where bond futures prices come from. To understand bond futures prices requires an understanding of cost of carry, repo rates and basis. Calculating the cheapest to deliver is based on these factors.

Cost of Carry

The price of bond futures is tied to the price of bonds in the cash market. As cash prices rise, futures prices also rise.

In simple terms, the futures price is determined in the following way. By borrowing the money to buy a bond today in the cash market, a person can sell it forward in the futures market. For example he might buy a *Bund* at its market price.

He would be content to sell it forward as long as he can receive a price higher than the price he has just paid.

Since he has to borrow the money to buy it, he will have to pay interest on the loan. This interest is known as *cost of carry*, and it normally increases the price of anything in the future. In this simple example, the cost of the interest is added to the cash market price in calculating the break-even price at which the bond must sell in the futures market.

With commodities, such as wheat, corn, or oil, cost of carry includes other items, such as transportation costs (the literal meaning of cost of carry is the cost to transport a commodity from the fields to the buyer), insurance, storage, etc.

With interest rate futures contracts, the primary cost of carry is interest expense. Other costs are brokerage fees, margin costs, and other transaction costs. The most important of these is interest expense.

Repo Rates

Repo rates are the usual interest expense for financing the purchase of a bond. Meaning the rate on a *repurchase agreement*, the repo rate is the market rate at which one can borrow money in order to purchase a bond in the cash market.

Mechanically, using a repo (a repurchase agreement) is very simple. As long as he has a good name and a telephone, a party can call a bond dealer and ask to buy a bond. The dealer will ask how he wants to pay for it, and he can tell him he wishes to "*repo it.*" This means he wishes to borrow the money from the dealer to buy the bond. He will leave the actual bond in the dealer's safekeeping, but he will be the owner, and he will owe the dealer interest on the loan at an agreed market rate. This rate is the repo rate. At the maturity of the loan, he can pay back the loan and the interest, and take possession of the bond. Or he can simply sell the bond back to the dealer at the current market price, and settle for the difference against the loan principal plus interest.

In this case, imagine he intends to take possession of the bond by repaying the loan and interest in full. He intends to do this because he is going to sell the bond through the futures market.

The repo rate is more or less equal to the short-term interbank rate for the period remaining through the futures market delivery date.

Conversion Factors

When someone delivers a government bond to satisfy an existing short futures position, he sells it for the futures price agreed when the trade is done. There is only one futures price for each future delivery date, no matter which bond he intends to actually deliver.

Since the list of deliverable bonds contains a great diversity of coupon sizes and remaining maturities, the clearing house must use a conversion factor to make the prices of the different deliverable bonds more or less comparable.

The device used on most bond futures contracts, is to calculate a price at which the bond would yield the theoretical coupon rate of the futures contract, 8% for Treasury bond futures and 6% for *Bund* futures. This price is the bond's conversion factor. We will look at one example from the old DTB Bund contract.

Calculating a Conversion Factor

Issue:	Bund
Maturity:	04-Jan-07
Coupon:	6%
Market Price:	103.250%
Conversion Factor:	0.999671
Face Value:	DM250,000

DTB uses a convention for calculating the conversion factor that alters the actual maturity of the bond by bringing it forward to the previous even 10th of the month. For example, the actual maturity of the 7 1/8% *Treuhand* above is 4 July 2007. For purposes of calculating the conversion factor, DTB sets the bond's maturity at 10 June 2007. Then a price is calculated which will yield the nominal coupon of 6%.

Conversion Factor:	
Delivery:	10-Sep-97
Maturity:	10-Dec-06
Price to yield 6%:	0.999671

Using a Conversion Factor

When a bond is tendered to the exchange, the *invoice price* is calculated as the futures settlement price multiplied by the conversion factor, plus accrued interest. If the above *Bund* with a face value of DM250,000 were delivered to the exchange on 10 September 1997 at a futures price of 102.80, for example, the delivery proceeds to the seller would be:

Example

Futures Price	102.80
Conversion Factor	0.999671
Converted Price	102.7662
Accrued Interest	
04-Jan-97	
10-Sep-97	4.1000
Settlement Price	106.8662
On Contract Value	DM267,165

Adding the accrued interest from the previous coupon date (actually the issue date) of 29 January 1993 through the futures delivery date of 10 December 1993, to this amount gives us the total amount of the delivery proceeds.

The Cheapest to Deliver Bond

In order to understand CTD, we will analyze a transaction wherein we buy a bond in the cash market and sell it in the futures market. Buying a bond in the cash market and selling it in the futures market, hoping to lock in a risk-free gain, is known as *cash and carry arbitrage*.

The futures market refers to the price of the bond in the cash market compared to the price of the bond in the futures market as *basis*. Basis considers the cost of financing at the repo rate.

Implied Repo Rates

Imagine the following transaction:

1. Buy a bond in the cash market and finance it using a repo.
2. Sell the bond future. You will earn the delivery proceeds, including accrued interest.
3. Compare the two amounts. Imagine a financing cost which makes them break even.

This is the implied repo rate.

The September 1997 *Bund* futures contract on DTB had a price of 102.80. Analysis of the cash and carry arbitrage using the bond above follows:

Settlement Date:	15-Jul-97
Futures Price:	102.80
Delivery Date:	10-Sep-97
Days:	57
Cash Market:	
Issue:	Bund
Maturity:	4-Jan-2007
Coupon:	6
Market Price:	103.250
Conversion Factor:	0.999671
Face Value:	DM250,000

The total price to buy the bond follows:

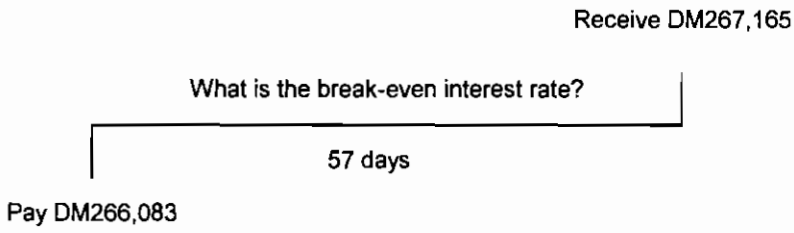
Market Price	103.2500
Accrued Interest	
04-Jan-97	
15-Jul-97	3.1833
Dirty Price	106.4333

On DM250,000 face value this comes to DM266,083.

The delivery proceeds are what the bond is worth on the delivery date through taking a short position in the futures market. This is exactly the same calculation already performed above, to calculate the total proceeds available on delivery of this bond. The delivery proceeds calculated above came to DM267,165.

Is there profit from this arbitrage? It depends on the financing cost. The break-even financing cost is the interest rate that makes the money to be repaid on the delivery date equal to the proceeds from the clearinghouse upon tendering the bonds.

This can be seen on a time line as follows:



The break-even interest rate is calculated as follows:

$$\left(\frac{267{,}165}{266{,}083}-1\right)\times\frac{360}{57}=2.5685\%$$

This financing cost is implied by this arbitrage. This is known as the implied repo.

If the financing rate is lower than the break-even rate, buying the bond in the cash market and selling it in the futures market is a profitable arbitrage. With the repo rate at a level of 6.50%, this arbitrage would actually be profitable. Normally this is not the case.

The implied repo rate is usually less than the cash repo rate. Why? Because the seller of the future has certain options when delivering the bond.

The seller can deliver the bond anytime during the month. The seller can deliver after the market closes. He can take advantage of economic news after the futures markets have closed, although this is less of a benefit to the seller now that the CBOT has night sessions. Also the seller has some timing options between actually notifying the exchange and delivering the bonds. These options are normally reflected in a lower futures price for the seller and hence a lower repo rate.

Basis

Basis compares the cost of the bond in the cash market to the cost of the same bond in the futures market.

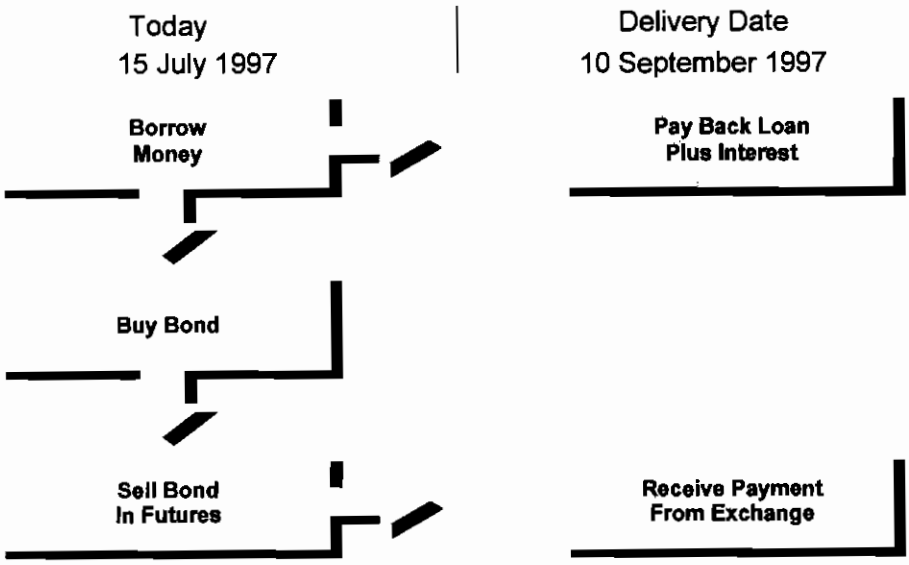
Net Basis

Net basis, also called *value basis*, is the difference in the two prices calculated above, expressed in the form of price points.

Net basis shows the profit or loss which would result from the cash and carry arbitrage financed at the market repo rate.

Comparing the financed price of buying the bond today and paying interest on the loan at the repo rate, to the total proceeds on delivery against a short position in the futures, calculates the net basis.

Here is a picture of the cash and carry arbitrage:



Putting amounts to the steps above shows the possible arbitrage.

In this case, profit amounts to DM220, which at DM25 per basis point of price (the tick value) represents net basis of 8.9 *basis points*. These basis points are expressed in terms of *price*, and should not be confused with basis points of interest rates.

Pay to Cash Market	DM266,083
Finance at 3.09%	DM267,385
Receive from Exchange	DM267,165
Difference	DM220
As ticks	8.8

Gross Basis

Comparing the gross price in the cash market to the gross price in the futures market gives us the *gross basis*:

Pay to Cash Market	DM258,125
Receive from Exchange	DM256,915
Difference	DM1,210
As ticks	0.484

Summary

- The oldest and most liquid futures contract covering changes in the value of governments bonds is the U.S. Treasury Bond future.
- All bond future contracts have specific deliverable bonds and tick values equal to the smallest price change of the underlying bond.
- Treasury Bond Futures trade on the Chicago Board of Trade (CBOT).
- *Bund* futures trade on Eurex.
- The cheapest to deliver bond (CTD) is the bond most likely to be delivered by the seller of a bond futures contract.
- The cheapest to deliver bond is the bond that the seller can purchase most cheaply in the cash market to deliver into the futures contract.
- The cheapest to deliver bond is, out of all the bonds that are currently deliverable into the futures contract, the one that has the greatest implied repo rate. This bond theoretically offers the investor the largest return if he were to buy it in the cash market today and sell it in the futures market in the future.
- In low interest rate environments, bonds with high coupons and short duration tend to be the cheapest to deliver bonds.
- In high interest rate environments, bonds with low coupons and long duration tend to be the cheapest to deliver bonds.
- Repo rates are the interest expense for financing a purchase of a bond.
- Cost of carry is the interest rate or repo rate that increases the price of the bond in the future.
- The conversion factor for a deliverable bond is the adjustment to the price with which the bond would yield the theoretical coupon for the futures contract (8% for Treasury futures and 6% for *Bund* futures).

- *Basis* or *Gross Basis* is the difference in price between a bond in the cash market and the price of the same bond in the futures market.
- *Net Basis* refers to the difference in price of the same bond in the cash market and futures market taking into consideration accrued interest, financing charges (repo rates) and coupons.

Using Futures to Hedge Government Bond Positions

Government bond futures are used to hedge the risk of eurobonds, corporate bonds, and other forms of long-term debt, to varying degrees of success. The fact is that there is often little correlation among government bond rates and other bond rates in the same currency over short periods of time, like a trading day or two. Over longer periods of time, long-term rates in the same currency seem to move more or less in tandem. Over shorter periods, however, the spreads separating them can change dramatically, destroying well-calculated hedge ratios and turning *hedges* into additional *positions*.

Hedging with Bond Futures

Hedge Ratio Calculations

In order to hedge bonds with bond futures, we have to know how many futures contracts to use to offset the risk in the underlying bonds. There are two basic approaches used by market practitioners, which are in fact related to each other. The first we will analyze compares the change in value of the underlying bond position for a 0.01% change in the fixed rate to a change in value in the futures contract for a 0.01% change in the rate. The ratio of change gives us a hedge ratio based on **the value of a basis point**.

The second approach is similar, but attempts to measure the relative change in the underlying position and the hedge by means of **modified duration**. Since modified duration is an index of price sensitivity to a change of rate, the results should be similar under the two methods.

We will use a simple portfolio of a single *Bund* to test the first method, and a small portfolio of Treasuries to test the second.

Value of a Basis Point

The portfolio we will hedge consists of the following bond:

Bond	Coupon	Maturity	Price	Yield	Face Value
Bund	6	9/15/2003	101.152	5.8390%	DM250,000,000

Since we own this bond, we will have to *sell futures* to hedge it. We are using the futures market to sell the bond *synthetically*.

Underlying Bond

To hedge this portfolio, we have to measure how much its value changes if the applicable yield moves by one basis point up or down. With a simple portfolio like this all we have to do is recalculate the price. In order to establish a good reference, let us load this bond into the calculator and calculate its yield. We also need to know the bond's actual PV, which is the sum of the market price and the accrued interest, the so-called *dirty price*. For hedging purposes, it is the dirty price that we are protecting.

We will calculate the new dirty price under both a 1 basis point rise and fall of the current market yield.

We can now make a table of the results:

Yield	Price	Change in Price	Average
5.848977%	102.194972	– 0.073695	
5.838977%	102.268667		0.073729
5.828977%	102.342430	+ 0.073763	

What the table tells us is that the price of the bond changes by 0.073729 each time the market yield changes by 0.01%. For our holdings of DM250,000,000, this means a change in value of:

$$\Delta PV = 0.073729\% \times DM250,000,000$$

$$\Delta PV = DM184,322.1525$$

The above equation is read, "*Delta* PV equals..." and means "the change in the PV..."

This is the value of one basis point in the underlying bond position, DM184,322.15.

Futures Contract

The value of the futures contract will change based on two rate changes: the yield of the cheapest to deliver bond ("the CTD") and the repo rate. The repo rate is the primary source of basis in the CTD — assuming that the implied repo of the CTD stays relatively near the market repo, or that the net basis remains fairly small — and is notoriously difficult to hedge. Using bond futures it is not possible to hedge the basis — hence the origin of the term *basis risk* — but we can hedge changes in the yield of the CTD.

The CTD is itself another source of risk: can we be sure that the spread between the yield of the CTD and the yield of the bond(s) we wish to hedge will remain constant? If it does not, the changing spread introduces another source of risk into the hedge.

If we assume that the basis will remain constant and that changes in the market yield of the CTD will be mirrored basis point for basis point by changes in the yield of the bond(s) we wish to hedge, we can calculate a hedge ratio in the following manner.

First, we have to calculate how the changing yield of the CTD will affect its market value. This is essentially the same comparison we made above for the bond we own. Then we calculate a new futures price — assuming no change in the implied repo rate for the CTD. This gives us the value of a 0.01% change in the yield of the CTD on a single futures contract.

Bond	Coupon	Maturity	Price	Yield	Modified Duration	Face Value
Treuhand	7 1/8	1/29/2003	107.363	6.0521%	6.3839	DM250,000

We can make a table of the results:

Yield	Price	Change in Price	Average
6.062064%	113.089748	– 0.072210	
6.052064%	113.161958		0.072242
6.042064%	113.234232	+ 0.072274	

We will use the average price change of 0.072242 in the CTD for a 0.01% change in its yield. The future value of this price change at the implied repo rate of 9.41% (calculated earlier) for 18 days (the period through delivery), adjusted by the conversion factor, gives us the value of the 0.01% on the futures price. The effect of using the FV at the implied repo rate is very small (less than 1/3 of a basis point), so we will ignore it and make the equation simpler.

This relationship can be reduced to a fairly straightforward formula, if we assume that the face value of the CTD is equal to the face value of a single futures contract:

$$\frac{\Delta PV_F}{100} \times FV_F \times CF = \frac{\Delta PV_{CTD}}{100} \times FV_{CTD}$$

$$\Delta PV_F = \frac{\Delta PV_{CTD}}{CF}$$

$$\Delta PV_F = \frac{0.072242}{1.076897}$$

$$\Delta PV_F = 0.067083$$

Where:

ΔPV_F	=	Change in price of 1 futures contract
FV_F	=	Face value of 1 futures contract
CF	=	Conversion factor for the CTD
ΔPV_{CTD}	=	Change in price of the CTD
FV_{CTD}	=	Face value of the CTD

The formula tells us that the price change we can expect in the futures contract for a 1 basis point change in the yield of the CTD is 0.067083, or 6.7083 ticks. Since each tick is worth DM25, and we have 6.7083 of them, the value of a 0.01% change in the yield of the CTD is DM167.71 per futures contract.

$$\Delta PV_F = 6.7083 \times DM25 = DM167.7075 \text{ per contract}$$

Hedge Ratio Calculation

Since we know the value of a 0.01% change in yields for both the underlying bond and for the futures contract, we can use the two values to calculate our hedge ratio:

$$\frac{DM184,322.15}{DM167.7075} = 1,099.07$$

This ratio tells us that we need to use 1,099 futures contracts to offset the change in PV on our portfolio from a 0.01% change in yields. This makes sense intuitively, as our cash position is roughly 1,000 times bigger than the face value of a single futures contract.

We need to use slightly more than 1,000 contracts because the PV of the CTD (and hence the futures) is less sensitive to changes in rates than is the PV of the newly issued (and longer duration) 6% *Bund*.

Modified Duration-Based Hedge Ratio

The above relationships can be stated a good deal more simply if we use modified duration to give us the value of the 0.01% change in yield. Since that is what modified duration is, i.e. an index of price sensitivity to changes in yields, this is a very reasonable approach. It is also easier!

We can summarize the above calculations into a single, fairly straightforward hedge ratio. The derivation of this ratio is beyond the scope of this self-instructional guide, but we can use it without having to know how to derive it. The logic is very similar to that followed above, as we are using the relative price sensitivity of the CTD (as the source of changes in the futures price) and the bonds we own to determine how many futures contracts to sell.

The basic relationship is as follows:

$$PV_U \times MD_U \times \Delta i_U = -\#C \times PV_{CTD} \times MD_{CTD} \times \frac{FV_F}{CF} \times \Delta i_{CTD}$$

Where:

PV_U	=	Market value of the underlying bond or portfolio of bonds
MD_U	=	Modified duration of the underlying bond or portfolio of bonds
Δi_U	=	Change in yield of the underlying bond or portfolio of bonds
#C	=	Number of futures contracts
PV_{CTD}	=	Market value of the CTD, expressed as a decimal
MD_{CTD}	=	Modified duration of the CTD
FV_F	=	Face value of the futures contract
CF	=	Conversion factor for the CTD

Δi_{CTD} = Change in yield of the CTD

The above formula can be read, "The market value of the underlying times the modified duration of the underlying times the expected change in yield of the underlying is to be offset by a change in the futures position equal to the number of futures contracts times the market value of the cheapest to deliver times the modified duration of the CTD times the face value of one futures contract divided by the conversion factor of the CTD times the expected change in yield of the CTD."

If we wish to know how many futures contracts to buy or sell, we must solve the above equation for #C:

$$\#C = -\frac{PV_U}{PV_{CTD}} \times \frac{MD_U}{MD_{CTD}} \times \frac{CF}{FV_F} \times \frac{\Delta i_U}{\Delta i_{CTD}}$$

Note that we are hedging the market value of the underlying position, i.e. its dirty price times the face value of our holdings. We will also assume that the yield spread between the CTD *Treuhand* and the *Bund* we own remains constant, so that the ratio of changes in the interest rates is 1 to 1. We might make any assumption we wish about this, actually, but the level of the spread is hard to predict.

We can use the above equation to solve for the number of contracts we need to sell in order to hedge our position in the new 6% *Bund* by plugging in the numbers:

$$\#C = -\frac{250{,}000{,}000 \times 102.268667\%}{113.161958\%} \times \frac{7.2093}{6.3839} \times \frac{1.076897}{250{,}000} \times \frac{0.01\%}{0.01\%}$$

$$\#C = -1{,}099.06$$

Again, we need to sell 1,099 December *Bund* futures contracts to protect our holdings of DM250,000,000 of the 6% *Bund* due 15 September 2003 from rising rates.

This is the same number of contracts we calculated above using the value of a basis point method. It should be, as modified duration is an index of price change given a change in rates.

We might also summarize the assumptions we have made, or the risks we are taking in hedging this position:

1. We assume no change in the yield spread between the CTD 7 1/8% *Treuhand* and the 6% *Bund* we own, currently 0.2131%.

2. We assume no change in the net basis or repo rate for the CTD, currently 0.164 and 9.41% respectively.

3. We also assume that the CTD bond does not change.

If all these assumptions are good, our hedge will work pretty well.

Adjusting the Duration of the Underlying Position

In the example above, we used the futures market to offset all of the duration of the underlying position.

In a similar fashion, we can use the futures to adjust the duration of our portfolio to a level we wish to target. To do so, we need only consider the *weighted average duration* of the portfolio we wish to achieve.

An important note is that futures cannot be used to extend the duration of a portfolio out past the duration of the CTD. By selling futures against a portfolio of bonds we own, however, we can use them to decrease the duration of the portfolio.

However much of our existing position we offset using futures, we reduce the duration to 0 for that amount of the position.

Above, for example, we brought the duration of our net position, owning the 6% *Bund* and selling 1,099 December 1993 *Bund* futures contracts, to 0.

We can express this relationship in a formula as follows:

$$\text{Hedge\%} \times \text{MD}_{\text{Hedge}} + (1 - \text{Hedge\%}) \times \text{MD}_{\text{U}} = \text{MD}_{\text{Target}}$$

Whatever percent of the underlying position we hedge, we reduce its duration, the MD_{Hedge} above, to 0. If we select a target duration, we can solve for the Hedge% we need to achieve it. This is a function of the duration of the underlying position. We can therefore simplify the above equation as follows:

$$\text{Hedge\%} = \frac{\text{MD}_{\text{U}} - \text{MD}_{\text{Target}}}{\text{MD}_{\text{U}}}$$

This equation shows us that if we wish to achieve target duration of 0, we have to hedge 100% of our underlying position:

$$\text{Hedge\%} = \frac{7.2093 - 0}{7.2093} = 100\%$$

If we wished to decrease the duration of the underlying position to 3, for example, we would have to hedge 58.39% of the position:

$$\text{Hedge}\% = \frac{7.2093 - 3}{7.2093} = 58.3871\%$$

We know from above that to hedge 100% of our underlying position, we would have to sell 1,099 contracts. Therefore to hedge 58.39% of our position, we have to sell 641 contracts:

$$58.3871\% \times 1{,}099 = 641.67$$

It should be noted that we are not actually changing the duration of the portfolio in terms of the tenor of the rates to which we have exposure. Rather, what we are doing is making smaller the impact of a change in the same rate on our portfolio. It is best to consider this decrease in duration not in terms of time, or years, but rather in terms of sensitivity. If we begin with an underlying position that is 100% sensitive to a change in the market yields affecting it, we can reduce the index of sensitivity to 0% by fully offsetting the underlying position through the sale of futures contracts.

In the example above, we have reduced the sensitivity of our position to changing rates from 100% to 41.61% (100% – 58.39%) by reducing the duration to 3.

Summary

- A hedge ratio determines how many futures contracts to use to offset the risk of an underlying bond.
- The change in the value of a bond for a 1 basis point change in rates is known as the value of a basis point.
- Either modified duration analysis or value of a basis point analysis can be used to determine the hedge ratio. The results should be similar.
- The dirty price of a bond is the market value plus any accrued interest. Hedging should control risk for the dirty price of a bond.
- The value of a futures price will change based on two rates - the yield of the cheapest to deliver bond and the repo rate.
- Changes due to the repo rate are difficult to hedge. However the changes in the yield of the cheapest to deliver bond can be hedged.
- If the spread between the yield on the cheapest to deliver bond and the bond being hedged does not remain constant, this will add another source of risk to the hedge.
- If the cheapest to deliver bond changes the hedge will need to be adjusted.

- Futures can be used to decrease the duration of a portfolio but futures cannot be used to increase the duration of a portfolio out past the duration of the cheapest to deliver.

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